# PERMIAN DEPOSITS OF SOUTH AUSTRALIA AND THEIR FAUNA*

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## SUMMARY

Lower Permian sediments occur in all the main sedimentary basins of South Australia. The Cape Jervis Beds are described, and the Lake Phillipson Beds and Stuart Range Beds formally named. In general, the formations follow a sequence of boulder clay overlain by sands and clays mostly of marine origin, with a widely distributed fauna of arenaceous foraminifera of which *Hyperammina, Ammodiscus,* and *Hemidiscus* are the most common. Twenty-three species, of which four are new, are recorded or described. The most varied fauna occurs in the Stuart Range Beds from which the gastropod *Peruvispira* was recovered.

## INTRODUCTION

As recently as 1955, Permian sedimentation in South Australia was so imperfectly known as, on a map of Australia showing regions of Permian sedimentation (Hill, 1955), to be restricted to glacial deposits in a southeast-northwest trough south of Adelaide, extending from Encounter Bay to western Yorke Peninsula. While this is still recognized as the main area of outcropping Permian glacigene sediments, Lower Permian sands and clays have been proved by exploratory drilling to occur widely in all the main sedimentary basins. Moreover, as reservoir beds for natural gas accumulation in the Great Artesian Basin, Permian rocks have assumed an economic importance not foreseen a decade ago (Sprigg, 1966).

Until foraminifera were discovered in the Permian section of Minlaton Stratigraphic Bore (Ludbrook, 1956), the depositional environment of most of the Permian sediments in South Australia was misunderstood. It was generally believed that the sandy nature of most of the deposits indicated a fluvio-glacial origin, and that "fluvio-glacial depositions in ponded waters are but rarely met with in our Permo-Carboniferous strata and marine depositions of this age are entirely absent" (Mawson, 1926). The ubiquity of foraminifera in the Lower Permian in all the main sedimentary basins, except that part of the Great Artesian Basin, including the Cooper's Creek Sub-basin, occurring in the northeast of the State, disproves this belief.

After initial over-deepening by ice, marine incursions in fjords or narrow troughs took place in two main and widely-separated areas following the general southeast-northwest trend. The southeastern area includes the Murray and St. Vincent Basins and the northwestern area the part of the Great Artesian Basin lying between the Peake and Denison Ranges, Stuart Range, and Margaret Creek.

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Localities from which Permian marine sediments have been proved in surface sections or by drilling are shown in Fig. 1.

All material and figured specimens are housed in the collections of the Geological Survey of South Australia, except those lent by the Geology Department, University of Western Australia (UWAGD).

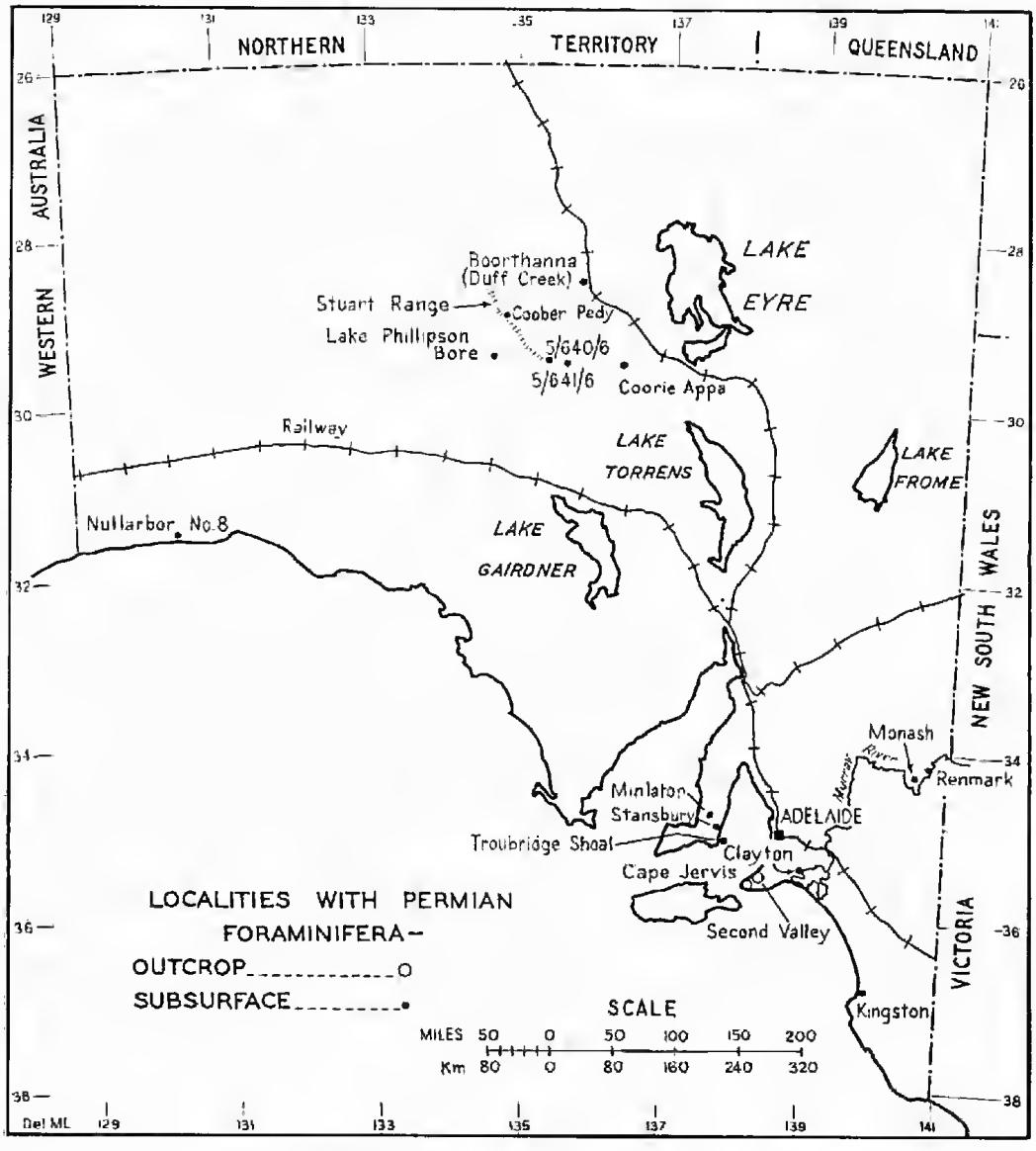


Fig. 1. Map showing localities with Permian foraminifera.

## ST. VINCENT BASIN AND ADJACENT AREAS

Since Selwyn's recognition in 1859 of glacial features in the valley of the Inman River, there has accumulated a considerable volume of descriptive literature on the Permo-Carboniferous or Permian glaciation and glacial deposits in

the St. Vincent Basin and adjoining areas to the east on Fleurieu Peninsula and to the west on Yorke Peninsula. The papers of Howchin (1926) and Campana and Wilson (1955) may be consulted for historical reviews and comprehensive lists of references.

Without designating any standard section, Howchin described most if not all of the known exposures of Permian deposits in the area between Adelaide and Kangaroo Island. The sequence at Hallett Cove he referred to as the "Hallett's Cove beds" (1895, p. 65), while the glacigenes of Inman Valley were variously designated "Inman Valley Shale" (1895, p. 68) and the "Inman River Beds" (1926, p. 102). Unfortunately, neither of the names Hallett Cove nor Inman is now available for stratigraphic purposes as they have been applied to other units.

The most complete outcropping sequences described by Howchin are those at Hallett Cove, Cape Jervis (David and Howchin, 1897) and King's Point, near Victor Harbor (1910a). Of these David and Howchin recognized the section at Cape Jervis as "the most extensive development of glacial till that has been up to the present observed in South Australia" (1897, p. 64). The section was illustrated but not redescribed by Campana and Wilson (1953, 1955).

The Cape Jervis exposure is here described by R. B. Wilson and the writer as the holostratotype section of the Permian deposits of St. Vincent Basin and the adjoining areas:

*Cape Jervis Beds* (Fig. 2).

*Type Section*: Jervis 1-mile geological sheet.

On coast, extending for one mile (1·609 km.) northeast of Cape Jervis Lighthouse, Hundred of Yankalilla, sections 212, 211, 3009, 3010.

*Thickness*: 98 feet (29·87 m.).

The Cape Jervis Beds are unconformable upon easterly dipping greywackes of the Cambrian Kanmantoo Group. They are overlain by kunkar. The type section is described as follows:—

| Unit | Lithology | Thickness feet | Thickness metres |
|---|---|---|---|
| 6 | Poor outcrop, grass covered slopes, probably clay as below, boulders on surface | 23·5 | 7·2 |
| 5 | *Clay shale*—grey-brown, fissile, gritty with scattered boulders, becoming red-grey mottled toward top | 29·5 | 9·0 |
| 4 | *Sandstone*—yellow-white, cross-bedded, with scattered calcareous pebbles | 5 | 1·5 |
| 3 | *Sandstone*—gritty sandstone and grit with boulders and thin interbeds of laminated fissile grey clay | 13 | 3·9 |
| 2 | *Till*—dark grey boulder till with clay-shale bands | 5 | 1·5 |
| 1 | *Till*—sandy till with boulders of all sizes, principally Kanmantoo greywacke and Victor Harbor Granite. Thin (6 inches to 1 foot; 0·15—0·3 m.) limestone bands | 22 | 6·7 |
| BASE | | | |
| | Total measured thickness of Cape Jervis Beds unconformably overlying Cambrian Kanmantoo Group | 98 | 29·8 |

The fossil locality number is 5/837/2 (Jervis 2). The grey clay and overlying red and grey gritty clay of bed 5 are fossiliferous, arenaceous foraminifera being present in samples C.J. 7 and C.J. 8. Abundant tests of *Recurvoides wilsoni* Ludbrook sp. nov. accompanied in decreasing order of abundance by

*Hyperammina coleyi* Parr, *Ammovertella howchini* Ludbrook sp. nov., *Digitina recurvata* Crespin and Parr, *Ammodiscus oonahensis* Crespin and *Hyperammina acicula* Parr.

The Cape Jervis Beds are extensively developed on Jervis and Yankalilla 1-mile sheets.

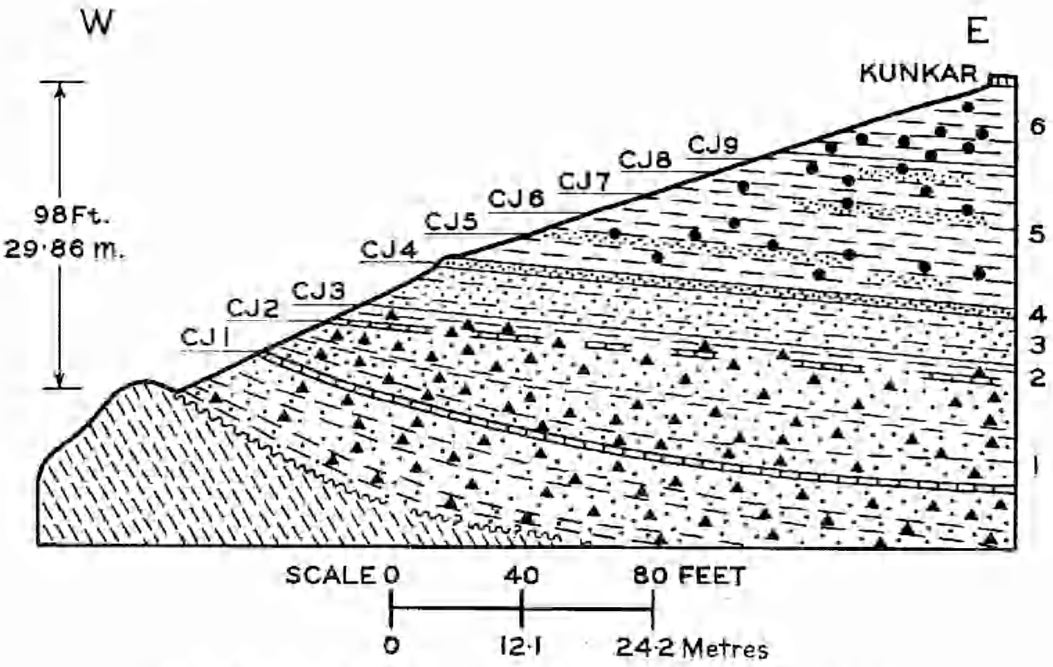


Fig. 2. Sketch of type section of Cape Jervis Beds, Cape Jervis.

A southerly view of the Cape Jervis section showing the Cape Jervis Beds (C.J.) overlying Kanmantoo greywacke (K) is shown on plate 1, figure 1. Fig. 2 illustrates the lower part of the section to the sandstone ledge at 40 feet (12 m.) above the base; the interbedded nature of the sandstone and clay and the tendency for the boulders to be bedded in some parts of the section is also shown at the position of the hammer. Fig. 3 illustrates the dip (probably depositional) and bedding of the same part of the section as figure 2, viewed south. Fig. 4 is that of a striated boulder on boulder clay at the most northerly end of the exposure.

The Cape Jervis Beds are very subject to gully erosion which is illustrated in plate 2, figure 1 of the northern part of the exposure.

The section at Cape Jervis provides confirmatory evidence of marine incursion in the Adelaide region following initial overdeepening by glaciation in the late Carboniferous to early Permian. Previously a few broken fragments of *Hyperammina* were recovered from clay collected by B. P. Thomson from Second Valley (locality Jervis 1, 5/837/1), but no other foraminifera had been observed in Permian glacigenes between Adelaide and Kangaroo Island.

Parastratotype sections of the Cape Jervis Beds are exposed at Hallett Cove where the formation rests on striated pavements now declared a national reserve, and at King's Point west of Rosetta Head, on Encounter Bay, where the sequence

of moraine, glacial till, and sandstone described and illustrated by Howchin in 1910 is still undisturbed (plate 2, figure 3).

At Selwyn's Rock (plate 2, figure 2) the southern bank of the Inman River has recently been considerably eroded at the position of the large erratic in boulder clay overlying the striated pavement.

Exposures, however, nowhere attain any great thickness, and Permian sedimentation in the Adelaide region consists for the most part of infilling of overdeepened glacial valleys and basins as those of Fleurieu Peninsula (Campana and Wilson, 1953, 1955) and Kangaroo Island where a bore at Kingscote in 1909-1910 intersected 950 feet (289 m.) of typical Permian sequence before bottoming in slate. Leaf impressions were collected in 1953 by R. C. Sprigg, then of the Geological Survey of South Australia, in Permian sediments three miles (4·8 km.) southwest of Penneshaw. Their fragmentary nature precluded identification at the Australian Museum other than that they were possibly portions of equisitaean stems.

In the St. Vincent Basin and adjoining areas only the lower part of the Permian sequence appears to be represented. The absence of coals and of good microflora-bearing clays demonstrates that the Artinskian and upper part of the Sakmarian are missing in this area. On the other hand, the occurrence of Permian megaspores in the lower Tertiary of the St. Vincent Basin suggests that the absence of the upper part of the sequence may be due to erosion rather than to non-deposition.

The Permian is 776 feet (236 m.) thick on Yorke Peninsula where it provides the clay pans for the salt lagoons which are exploited for commercial salt production. The sequence was completely intersected in Minlaton and Stansbury Bores (Ludbrook, 1966a). In Beach Petroleum Troubridge Shoal No. 1 Stratigraphic Well, 750 feet (228 m.) of Permian sediments were cut between 850 feet and the total depth of the well. Foraminifera occurring sporadically between 1,010 and 1,550 feet (307·8 and 472·4 m.) permit close correlation with the marine interval in Stansbury Bore. Here also the upper Sakmarian-Artinskian carbonaceous sediments are absent.

## MURRAY BASIN

Presumed Permian glacigene sediments were proved by drilling in the Murray Basin in South Australia at Renmark, Monash and Clayton. A.O.C. North Renmark No. 1 entered at 3,245 feet (989 m.) blue-grey boulder clay irregularly interbedded with calcareous sandstone in irregular lenticles and laminae. Slump structures were common, while erratic pebbles and grains of quartz, granite, grey metamorphic rocks and dark pink feldspar were variously scattered throughout the groundmass. Faceted pebbles were recovered at 3,431 feet (1,045 m.). At 3,788 feet (1,154 m.) (Core 15) there was a calcareous pyritic quartz sandstone, and at 3,884 feet (1,184 m.) (Core 16) blue-grey shale irregularly interbedded with lenses of calcareous sandstone containing pink feldspar, biotite and pink garnet. The well bottomed in sandstone with scattered coal fragments and conglomerate bands, small slump structures and swirls of fine clay. Foraminifera occurred in almost all the cuttings between 3,410 and 4,000 feet (1,039 and 1,219 m.), but as none were recovered from cores their persistence does not necessarily indicate marine environment for the lower part of the interval.

Similar sediments with a few foraminifera were intersected in Beach Petroleum Monash No. 1 Well between 2,930 and 3,320 feet (893 and 1,011 m.). The formation was conglomeratic at 3,285 feet (1,001 m.).

A considerable thickness of at least 1,600 feet (487 m.) of Lower Permian sands and shale was intersected in W.G. Goyder Donna No. 1 Well drilled at Clayton, 5½ miles south-southwest of Milang, near the southwestern margin of the Murray Basin. At 500 feet (152 m.) the well passed into brownish mudstone with fine muscovite and some carbonaceous matter. This was a thin bed overlying pyritic sand with subangular to subrounded quartz and pink garnet grains, grading to sandstone and sand with some interbeds of fine-grained calcareous sandstones. The quartz grains were more or less rounded, with pitted surfaces; pink garnet was common and pyrite usually present with accessories of muscovite, feldspar and lithic grains. A few foraminifera, either *Ammodiscus* or *Hemidiscus*, were present in most samples between 540 and 1,050 feet (164 and 320 m.).

Without the evidence of foraminifera these sediments would be regarded as "fluvio-glacial". In Donna No. 1 Well there is less evidence of boulder clay, while the sands for the most part are worn and of reasonably uniform size. The section therefore corresponds to the Lower Sakmarian marine sediments in the Yorke Peninsula bores. Owing to drilling difficulties good bottom cores were not obtained to prove the base of the sequence.

Sediments of possible Permian age with a species of *Trochammina* not known from other Permian sediments in South Australia occur below 255 feet (77 m.) in a water bore at Blackford on section 500, Hundred of Murrabinna.

## GREAT ARTESIAN BASIN

### *Western Part — Lake Phillipson and Boorthanna Troughs*

Following the recognition of 2,000 feet of Permian sediments in Lake Phillipson Bore (Balme, 1957), the sequence of Lower Permian rocks underlying the western part of the Great Artesian Basin was described by Ludbrook (1961), and the history of their deposition and geological setting reviewed by Wopfner (1964). The Lake Phillipson and Boorthanna Troughs between Lake Phillipson and the Peake and Denison Ranges contain the most complete succession identified by Balme as Sakmarian-Artinskian, consisting in upward sequence of a maximum of 2,974 feet of glacial till and boulder clay, marine mudstones and siltstones, overlain by *Glossopteris*- and *Gangamopteris*-bearing freshwater silts and clays with sandstone and coal interbeds now described from the Arckaringa Sub-basin as the Mount Toondina Beds (Freytag, 1965). All but the uppermost coal beds were recently intersected between 490 feet (149 m.) and the total depth of 2,043 feet (623 m.) in Stuart Range No. 3 Bore, drilled by the South Australian Mines Department in search of additional underground water supplies for Coober Pedy Opalfield. The marine formation below the Mount Toondina Beds in this well provided the most significant fauna so far recovered from the South Australian Permian. Stratigraphic, lithological, and palaeontological details of this well are in press (Ludbrook, 1967).

Except for the Mount Toondina Beds, the Permian sediments in the Lake Phillipson and Boorthanna Troughs have not been formally named. Balme (1964) informally used the names "Lake Phillipson Coal", "Lake Phillipson Glacials", in tabulating the stratigraphic position of pre-Tertiary micro-floras, and the names "Coober Pedy Beds" and "Stuart Range Beds" on a locality map of Permian localities from which palynological data were available. It is here

proposed to formalize the names Lake Phillipson Beds for the glacigenes at the base of the sequence and Stuart Range Beds for the mudstones and siltstones, marine in part at least, between the glacigenes and the Mount Toondina Beds, using Lake Phillipson Bore (Ludbrook, 1961) as the standard subsurface section.

The *Lake Phillipson Beds* are so named to avoid further duplication of stratigraphic names for the glacigene boulder clays or till at the base of the Permian sequence. It is recognized that the boulder beds occur in outcrops on the Oodnadatta and Warrina 1:250,000 sheets from which a type section might be selected to comply with the Australian Code of Stratigraphic Nomenclature. The relationship of these outcrops to the Lake Phillipson Beds or to the Crown Point Formation of the Northern Territory is not, however, firmly established. Scattered occurrences of Permian(?) tillite were briefly described and mapped in the Peake and Denison Ranges west of Mount Dutton, 45 miles (7·2 km.) north-northeast of Warrina, three miles (4·8 km.) northeast of Duff Creek Siding and three miles (4·8 km.) northeast of Box Creek Siding (Reyner, 1955).

In the standard section, the Lake Phillipson Beds occurring between 2,357 feet (718 m.) and 3,140 feet (957 m.) overlie granite basement and consist of the sequence already described (Ludbrook, 1961) of 783 feet (238·7 m.) of grey boulder clay with some limestone and calcareous sandstone.

The Lake Phillipson Beds were intersected in Stuart Range No. 3 Bore between 1,660 feet (505 m.) and the total depth 2,043 feet (623 m.) in which the formation consisted of 100 feet (30·4 m.) of pinkish sandstone with scattered coarse quartz grains, red feldspar, pyrite, biotite, pink garnet, granite pebbles and 283 feet (86·2 m.) of boulder conglomerate with granite and other boulders of heterogeneous rock types.

The formation was also intersected in Coorie Appa and Margaret Creek Bores (Ludbrook, 1961).

*The Stuart Range Beds* overlie the Lake Phillipson Beds. So far they have not been recognized in outcrop. They are 1,613 feet (491·6 m.) thick between 744 feet (226·7 m.) and 2,357 feet (718 m.) and were described (Ludbrook, 1961) as a sequence of 88 feet (26·8 m.) of blue-grey mudstones with foraminifera, overlain by 1,525 feet (464·8 m.) of sandstones and siltstones. Only the lower unit in Lake Phillipson Bore appears to contain foraminifera.

The Stuart Range Beds are well distributed in the Coober Pedy-Stuart Range area of the Lake Phillipson Trough and in the Boorthanna Trough. They were intersected between 910 feet (277 m.) and 1,660 feet (505 m.) in E. & W.S. Stuart Range No. 3 Bore where they contained an abundant and persistent fauna of foraminifera with rare molluscs, ostracodes and vertebrate remains. They are represented in samples of grey clay collected from spoil from three bores on Balta Baltana Station on Billa Kalina 1:250,000 sheet, Balta and Ware 1-mile sheets. The depths at which the Stuart Range Beds were intersected are not known accurately, but they are known to underlie the Lower Cretaceous Marree Formation. Localities of the bores Balta Baltana No. 1 (Ware 5, 5/641/5), No. 2 (Ware 3, 5/641/3), No. 3 (Balta 6, 5/640/6) are shown on Map 8 Billa Kalina (Ludbrook, 1966b). All contained foraminifera which were abundant at locality 5/641/5. In the Boorthanna Trough the beds appear to attain their greatest thickness of 1,903 feet (580 m.) in Boorthanna (Duff Creek) Bore, thinning out to the south to 240 feet (73 m.) in Coorie Appa Bore and rapidly disappearing to the east of a line between Boorthanna, Anna Creek and Coorie Appa.

It may be anticipated from seismic data (Moorcroft, 1964; Freytag, 1965) and the Permian isopach map of Kapel (1966) that over 3,000 feet (914 m.) of similar sediments occur in the Arckaringa Sub-basin southwest of Oodnadatta and north of the Boorthanna Trough.

*Northern South Australia: Simpson Desert*

Lower Permian sections were intersected in two wells, Witcherrie No. 1 and Purni No. 1 of French Petroleum Company (Australia) Pty. Ltd., located in the north of South Australia on the southern margin of the Simpson Desert. The sequence consisted of an upper unit 41 feet (12 m.) thick of dark shale with coal and a lower unit consisting of 290 feet (88 m.) of sandstone and shale and 241 feet (80 m.) of siltstone and shale with quartzite pebbles (Canaple and Smith, 1965). The upper unit which has been compared with the coal sequence in Lake Phillipson Bore presumably belongs to the Mount Toondina Beds, while the lower unit is regarded by Canaple and Smith as equivalent to the Crown Point Formation.

*Northeastern South Australia: Cooper's Creek Sub-basin*

In the Permian of the Cooper's Creek Sub-basin to the northeast of South Australia gas discoveries have been made on the Gidgealpa and Moomba structures. The sequence of three disconformably transgressive units has been named (Kapel, 1966) the Gidgealpa Formation.

The Permian sediments were described by Greer (1965) as sandstones, lignitic shales and coals which accumulated in alternating coastal swamps, brackish lagoonal and shallow-water marine environments. In Gidgealpa No. 1 Well, the Permian is "underlain by 400 feet of Permo-Carboniferous marine shales and sands". Kapel (1966) subdivided the Gidgealpa Formation into three subunits: a lower of sandstone, shale and coal; a middle of shale, siltstone and minor coal; a top subunit of sandstone minor shale and coal. Wopfner (1966) divided the Formation into a lower Permian unit of conglomerate and sedimentary breccia in black or dark grey silty matrix, and carbonaceous shale interbeds, and an upper Permian unit of light grey fine- to very coarse-grained sandstone, dark grey carbonaceous shale and coal seams.

The Formation therefore has yet to be formally defined. The highly carbonaceous nature of most of the sequence is in contrast to the low carbon content of the light grey claystones and sandstones containing foraminifera which occur over the boulder clays elsewhere in South Australia.

Upper Permian carbonaceous siltstone, silty sandstone, conglomerate and arkosic crossbedded sandstone with coal and plant remains were intersected in Delhi-Frome-Santos Innamincka No. 1 Well in the northeast of the State.

## EUCLA BASIN

Knowledge of Permian sediments in the Eucla Basin is limited to the single occurrence of Artinskian fossiliferous clay in Nullarbor No. 8 (Yangoonabie) Bore (Harris and Ludbrook, 1966).

## FAUNA AND AGE OF THE PERMIAN DEPOSITS

The fauna contained in the Cape Jervis Beds, the Stuart Range Beds, and their equivalents, is sparse, indicative of a restricted environment of low temperatures or low salinity. With two exceptions, the faunal assemblage consists

only of 23 species of arenaceous foraminifera, of which species of *Hyperammina*, *Ammodiscus*, and *Hemidiscus* are the most common and ubiquitous. *Hippocrepinella biaperta* Crespin and *Reophax thomasi* (Crespin) are distributed in small numbers in all the sedimentary basins; *Lagenammina ampulla* (Crespin) and *Glomospirella nyei* Crespin are restricted to the Lake Phillipson trough; *Thuramminoides sphaeroidalis* Plummer, *Ammovertellina* (?) *glomospiroides* Ludbrook sp. nov., *Glomospira adhaerens* Parr, *Tolypammina undulata* Parr, *Recurvoides wilsoni* Ludbrook sp. nov., are well distributed frequently in abundance. As the foraminiferal fauna is almost entirely endemic it provides no reliable basis for correlation. *Thuramminoides sphaeroidalis* described from the American Pennsylvanian is known to have a range of Middle Silurian to Permian, while (?)*Hyperammina expansa* (Plummer) was described from the Middle Pennsylvanian Strawn Group of Texas.

The most significant fossil so far recovered is the gastropod *Peruvispira* in Stuart Range No. 3 Well at 1,285-1,305 feet. This genus, known only from Lower to Middle Permian marine rocks, confirms the Permian age of the Stuart Range Beds determined by Balme (1957) from microfloral evidence. In Stuart Range No. 3 Well the single specimen of *Peruvispira* was associated with a fragment of ? *Conularia*. Other sparse elements of the fauna include ostracodes and vertebrate remains which have not been identified.

## SYSTEMATIC DESCRIPTIONS

### Order FORAMINIFERIDA

### Superfamily AMMODISCACEA

### Family ASTRORHIZIDAE

### Subfamily RHIZAMMININAE

### Genus HIPPOCREPINELLA Heron-Allen and Earland, 1932

#### **Hippocrepinella biaperta** Crespin

pl. 3, fig. 1

1958. *Hippocrepinella biaperta* Crespin, 37, pl. 1, figs. 1-18.

*Description.* Test free, broadly elongate, consisting of a single tube open at both ends, sides parallel, ends constricted, the greatest constriction towards the aperture which is surrounded by a more or less thickened lip, aboral end open, less thickened when it is preserved, but usually broken off; wall thick, wrinkled, agglutinating, consisting of quartz grains in a siliceous matrix.

*Dimensions.* Hypotype Ff379, length 1·05, width 0·25 mm.

*Type Locality.* Oonah, Tasmania; Quamby Mudstone.

*Material.* Hypotype G.S.S.A. Ff379; 51 specimens.

*Distribution.* Minlaton Bore, Stuart Range No. 3 Bore, Fossil localities Ware 5 (5/641/5) and Balta 6 (5/640/6), Nullarbor No. 8 Bore, A.O.C. North Renmark No. 1 Bore.

*Stratigraphic Range.* Lower Permian.

### Subfamily HIPPOCREPININAE

### Genus HYPERAMMINA Brady, 1878

#### **Hyperammina acicula** (Parr)

pl. 3, fig. 7

1942. *Hyperamminoides acicula* Parr, **105**, pl. 1, figs. 4, 5; pl. 2, fig. 4.

1958. *Hyperammina acicula*; Crespin, **44**, pl. 5, fig. 11; pl. 6, fig. 7 (synonymy).

*Hyperammina acicula* is a large tapering species with a thick smoothly finished wall with much cement. Fragments only have been recovered in South Australia, but they compare with paratype material.

*Dimensions.* Holotype length 11 mm., greatest diameter 1·3 mm., paratype on UWAGD slide 20767 length 11 mm., greatest diameter 1·2 mm.; the figured hypotype GSSA Ff370 is only 1 mm. long.

*Material.* UWAGD 20767 five paratypes, 20770 three paratypes, 20771 one paratype, 20772 four paratypes. 195 fragments in South Australian samples.

*Distribution.* Stansbury and Minlaton Bores; locality Balta 6 (5/640/6), Boorthanna, Coorie Appa and Stuart Range No. 3 Bores; Goyder Donna No. 1 Bore; Nullarbor No. 8 Bore.

*Stratigraphic Range.* Lower Permian.

### Hyperammina coleyi Parr

pl. 3, figs. 8, 9

1942. *Hyperammina coleyi* Parr, 104, pl. 2, fig. 3; 1958, Crespin, 46, pl. 6, figs. 5, 6; pl. 7, figs. 3-5; pl. 33, figs. 1-2.

*Hyperammina coleyi* is a large species with a subglobular proloculus and a slender tubular chamber of lesser diameter than the proloculus. The wall is thick, firmly but not smoothly cemented as in *H. acicula*; the surface is rough.

*Dimensions.* The type series ranges in length to 9 mm., the proloculus diameter 0·5-1 mm., tubular chamber diameter 0·5 mm. Figured hypotype GSSA Ff371 proloculus diameter 0·55, diameter of tube 0·45 mm.

*Material.* UWAGD 20766 three paratypes, 20769 one paratype, 20770 two paratypes, 20771 four paratypes, 20772 one paratype; 100 fragments in South Australian samples.

*Distribution.* Cape Jervis; Stuart Range No. 3, Stansbury and Nullarbor No. 8 Bores.

*Stratigraphic Range.* Lower Permian.

### (?) Hyperammina expansa (Plummer)

pl. 3, fig. 10

1945. *Hyperamminoides expansus* Plummer, 223, pl. 16, figs. 1-6.
1958. *Hyperammina expansa*; Crespin, 49, pl. 4, figs. 9-11.

Short flaring specimens with a thick wall and apparently wide aperture in undamaged specimens belong to the species referred by Crespin (1958, p. 49) to *Hyperamminoides expansus* Plummer. As the genus *Hyperamminoides* has been synonymized by Loeblich and Tappan (1964) with *Hippocrepina*, and Conkin (1961, p. 261) has noted similarities between *H. expansa* and the microspheric form of *Hyperammina casteri* Conkin the specific identification and affinities of the Australian species must remain in doubt.

*Dimensions of Figured Specimen.* Height 0·4, diameter 0·4 mm.

*Type Locality.* Algerita, Texas, U.S.A.; Strawn Group, Middle Pennsylvanian.

*Material.* Hypotype GSSA Ff372; 11 specimens.

*Distribution.* Stansbury, Coorie Appa, Stuart Range No. 3 and AOC North Rennark No. 1 Bores.

*Stratigraphic Range.* Middle Pennsylvanian; ?Lower Permian.

**Hyperammina hebdenensis** Crespin

pl. 3, figs. 2-6

1958. *Hyperammina hebdenensis* Crespin, 52, pl. 6, figs. 8-12.

*Description.* Test free, small, broad, straight, consisting of a globular proloculus followed by a nearly straight tubular second chamber; wall agglutinating, moderately thin, with fine quartz grains in much cement. The cement is usually siliceous but some specimens have calcareous cement. Aperture a large circular opening at the end of the tube.

*Dimensions.* Hypotype GSSA Ff375 length 0·75, proloculus diameter 0·25; hypotype GSSA Ff376 length 1·26, diameter 0·6 mm.

*Type Locality.* Hebden, N.S.W., Mulbring Subgroup.

*Material.* 526 fragments.

*Distribution.* Ubiquitous in South Australian material.

*Stratigraphic Range.* Lower Permian.

*Observations.* It is not always easy to distinguish *H. hebdenensis* from *H. coleyi* when they usually occur as tubular fragments. In this study the two have been differentiated by the wall thickness with relatively little cement in *coleyi*; the smaller size, relative smoothness of the wall finish and the fact that the tube diameter is only a little less than that of the proloculus in *H. hebdenensis*.

Family SACCAMMINIDAE

Subfamily SACCAMMININAE

Genus LAGENAMMINA Rhumbler, 1911

**Lagenammina ampulla** (Crespin)

pl. 3, fig. 14

1958. *Pelosina ampulla* Crespin, 42, pl. 2, figs. 1-3.

*Description.* Test free, consisting of a single flask-shaped globular chamber; wall agglutinating, consisting of very fine quartz grains in much siliceous cement; aperture usually oval, terminal, at the end of a short neck.

*Dimensions.* Hypotype length 1·00, width 0·8 mm.

*Type Locality.* Oonah, Tasmania; Quamby Mudstone.

*Material.* Hypotype GSSA Ff387; 7 specimens.

*Distribution.* Locality Ware 5 (5/641/5), Stuart Range No. 3 Bore.

*Stratigraphic Range.* Lower Permian.

*Observations.* Conkin (1961, p. 248) noted the obscurity of the affinities of *Proteonina* Williamson, 1858, *Lagenammina* Rhumbler, 1911, and *Saccammina* Sars, 1869. *Pelosina ampulla* Crespin possesses the diagnostic features of *Lagenammina* rather than those of *Pelosina* as it has been redefined by Loeblich and Tappan (1964, p. C200).

Genus SACCAMMINA M. Sars in Carpenter, 1869

**Saccammina orca** Ludbrook sp. nov.

pl. 3, figs. 11-13

*Description.* Test free, large, solid, consisting of a single globular chamber of somewhat variable shape; it is commonly barrel-shaped with irregular annular constrictions but may be flatly spherical without apertural neck, or flask-shaped with a broad neck; wall thick, consisting of an inner pseudochitinous layer and

an outer layer of quartz grains held together by calcareous cement; exterior roughly finished; aperture oval, usually without neck, but may be at the end of a broad, short neck.

*Dimensions.* Holotype Ff384 length 1·8, diameter 1·1; paratype Ff385 length 1·15, diameter 0·75; paratype Ff386 length 1·2, diameter 1·1 mm.

*Type Locality.* E. & W.S. Stuart Range No. 3 Bore, 1,305 feet 8 ins.-1,327 feet.

*Material.* 368 specimens.

*Distribution.* Stansbury Bore; locality Balta 6 (5/640/6), Boorthanna, Lake Phillipson, Stuart Range No. 3 and Nullarbor No. 8 Bores.

*Stratigraphic Range.* Lower Permian.

The specific name is taken from the Latin noun *orca*, a jar or pot.

Genus Sacculinella Crespin, 1958

**Sacculinella australae** Crespin

One specimen doubtfully referable to this species was recovered from A.O.C. North Renmark No. 1, 3,410-3,415 feet. *Sacculinella* Crespin has been synonymized with *Brachysiphon* Chapman by Loeblich and Tappan, but there seems to be insufficient support for this view from the material available.

Genus Thuramminoides Plummer, 1945

**Thuramminoides sphaeroidalis** Plummer

pl. 3, figs. 15, 16

1945. *Thuramminoides sphaeroidalis* Plummer, **218**, pl. 15, figs. 4-10; Crespin, 1958, 40, pl. 3, figs. 9-11; pl. 31, figs. 1-2; Conkin, 1961, **243**, pl. 17, figs. 1-10; pl. 18, figs. 1-4; pl. 26, figs. 1-3.

*Description.* An amended description of the species has been given by Conkin (1961). South Australian specimens are always preserved as deflated or flattened discs. The wall is finely arenaceous with agglutinated quartz grains cemented by siliceous material in some tests and calcareous material in others. Of 162 tests examined 38 had calcareous cement; these all came from Stuart Range No. 3 Bore with the exception of one specimen from Ware 5, locality 5/641/5, and three from Stansbury Stratigraphic Bore. The development of protuberances on some of the tests is similar to that on Texas specimens.

*Dimensions.* The species shows a considerable range in diameter as shown by Conkin (1961, p. 247), with whose measurements (in mm.) those from the different South Australian localities may be compared.

| | |
|---|---|
| Locality 5/641/5 | 0·6 (1 specimen) |
| Stansbury Stratigraphic Bore | 0·4-0·5 (14 specimens) |
| Minlaton Stratigraphic Bore | 0·4-0·7 (8 specimens) |
| Boorthanna Bore | 0·4-0·75 (10 specimens) |
| Lake Phillipson Bore | 0·25-0·65 (4 specimens) |
| Stuart Range No. 3 Bore | 0·5-2·25 (69 specimens) |
| Nullarbor No. 8 Bore | 0·5-1·0 (47 specimens) |

The South Australian specimens are on the whole of medium size. The largest specimens with diameter of 1·75 mm. or more are smooth specimens with protuberances (pl. 3, fig. 16).

*Wall Structure.* The problem of the cementing material and the possible replacement by silica of original calcite is not resolved in the present study.

Some tests of both *Thuramminoides sphaeroidalis* and *Hyperammina hebdenensis* have calcareous cement in certain samples. Both species occurring in Ware locality 5/641/5 and at depths of 1,225 to 1,367 feet in Stuart Range No. 3 Bore have both calcareous and siliceous tests in the same sample. Tests of *Thuramminoides sphaeroidalis* have siliceous cement at depths of 740 to 1,225 feet and calcareous cement below 1,367 feet in Stuart Range No. 3 Bore, while all the tests in Minlaton, Boorthanna, Lake Phillipson, Stansbury, and Nullarbor No. 8 had siliceous cement. On the other hand, some tests of *Hyperammina hebdenensis* from Nullarbor No. 8 have calcareous cement.

*Australian Species of* Thuramminoides. Conkin (1961, p. 243) has placed *Crithionina teicherti* Parr, which was transferred by Crespin to *Thuramminoides*, in synonymy with *Thuramminoides sphaeroidalis*. The two species are, in the opinion of the present writer, specifically and generically distinct from each other. Seven slides containing some of Parr's original type material were kindly lent by the Department of Geology, University of Western Australia. While the holotypes so far cannot be located slides 20768 and 20772 contain topotypes of *Crithionina teicherti* from Parr's original material. Slide 20768 has seven mounted specimens which, with one exception 1·8 mm. in diameter, range from 2·0 to 2·5 mm. in diameter. They are spherical and uncrushed with a loosely cemented wall 0·2 mm. thick. The otherwise smooth outer surface of the wall is marked irregularly by small openings of the irregular canals contained in the thick wall. The inner surface is strongly and irregularly punctured with larger openings.

From the limited amount of material available the genus *Oryctoderma* Loeblich and Tappan, 1961 (type species *Crithionina rotundata* Cushman) is to be preferred for *Crithionina teicherti*. The test wall is relatively thinner than that of either the type species or of *O. palaeozoica* (Conkin), but the spongy wall texture may be seen where there has been limonitic infilling, and the small round or polygonal openings on the exterior surface are not characteristic of *Thuramminoides*. The wall texture differs also from that of South Australian specimens of *Thuramminoides sphaeroidalis*. *Oryctoderma teicherti* has not so far been recognized in the South Australian Permian.

*Type Locality.* *Thuramminoides sphaeroidalis* was described from the Middle Pennsylvanian lower Strawn Shale, east of San Saba, Texas, U.S.A.

*Material.* Hypotypes GSSA Ff377, Ff378; 162 specimens.

*Distribution.* The species is widely distributed in Stansbury, Minlaton, Boorthanna, Lake Phillipson, Stuart Range No. 3 and Nullarbor No. 8 Bores and locality Ware 5 (5/641/5).

*Stratigraphic Range.* Middle Silurian to Permian.

## Family AMMODISCIDAE

### Subfamily AMMODISCINAE

### Genus AMMODISCUS Reuss, 1862

### **Ammodiscus oonahensis** Crespin

pl. 3, figs. 17, 18

1958. *Ammodiscus oonahensis* Crespin, 69, pl. 12, figs. 10, 11.

*Description.* Test free, depressed in the centre, consisting of a small proloculus and long undivided second chamber closely planispirally wound in about 6 volutions with occasional growth constrictions; sutures distinct, slightly depressed; chamber in last volution broad; aperture at end of second chamber, slightly arched.

*Dimensions.* Hypotype, greatest diameter 0·825, thickness 0·20 mm.

*Type locality.* Oonah, Tasmania; Quamby Mudstone.

*Material.* Hypotypes GSSA Ff402, 403; 215 specimens.

*Distribution.* W.G. Goyder Donna No. 1, A.O.C. North Renmark No. 1, Stansbury, Minlaton, Beach Petroleum Troubridge Shoal No. 1, Boorthanna, Coorie Appa, Stuart Range No. 3 and Nullarbor No. 8 Bores; localities Balta 6 (5/640/6) and Ware 5 (5/641/5).

*Stratigraphic Range.* Lower Permian.

Genus HEMIDISCUS Schellwien, 1898

**Hemidiscus balmei** Ludbrook sp. nov.

pl. 3, figs. 19-21

*Description.* Test fairly large, irregularly discoidal, depressed in the centre, consisting of a proloculus and an undivided tubular second chamber at first planispirally wound like *Ammodiscus* then coiling unevenly so that later whorls lap over the earlier whorls on one side; there are about five volutions in a specimen of diameter 2·4 mm.; growth constrictions may occur at the former positions of the aperture; diameter of second chamber increasing very gradually; sutures distinct, slightly depressed; aperture at the open end of the tubular chamber.

*Dimensions.* Holotype Ff399 diameter 1·3 mm.; paratype Ff400 diameter 0·7 mm.; paratype Ff401 diameter 2·4 mm.

*Type Locality.* Stuart Range No. 3 Bore, 1,225 feet 3 ins.-1,246 feet depth.

*Material.* Holotype GSSA Ff399; paratypes GSSA Ff400, 401; 212 specimens, including 61 topotypes.

*Distribution.* Common in W.G. Goyder Donna No. 1 Well between 600 and 2,073 feet; Stansbury, Beach Petroleum Troubridge Shoal No. 1, Boorthanna, Coorie Appa, Stuart Range No. 3 and Nullarbor No. 8 Bores.

*Stratigraphic Range.* Lower Permian.

The specific name acknowledges the contribution made by Mr. B. E. Balme to understanding the South Australian Permian.

Genus AMMOVERTELLINA Suleymanov, 1959

**Ammovertellina(?) glomospiroides** Ludbrook sp. nov.

pl. 3, figs. 22-26

1958. *Ammovertella inclusa* Crespin, 72, pl. 18, fig. 5 (*non* Cushman and Waters).

*Description.* Test free, fairly small, consisting of a proloculus followed without any distinct separation by an undivided tubular second chamber of uniform diameter throughout; flatly streptospirally coiled in the initial stages then more or less planispiral; in the final stages the tube swings over and embraces the earlier coils at right angles to its previous plane of coiling. Wall thick, agglutinating, consisting of quartz grains well cemented in siliceous cement; aperture arched, at the end of the final coil.

*Dimensions.* Holotype greatest diameter 1·0 mm., diameter of chamber 0·25 mm.

*Type Locality.* Stuart Range No. 3 Bore, 1,265-1,285 feet.

*Material.* Holotype GSSA Ff396, paratypes GSSA Ff397, 398; 230 specimens.

*Distribution.* Locality Ware 5 (5/641/5), Stansbury, Minlaton, Boorthanna, Lake Phillipson, Stuart Range No. 3 and Nullarbor No. 8 Bores.

*Stratigraphic Range.* Lower Permian.

*Observations.* This is the species identified by Crespin with *Ammovertella inclusa* (Cushman and Waters). Unlike *A. inclusa* the species is not attached nor when sectioned does it show the planispirally coiled early portion figured by Conkin (1961, pl. 23, fig. 8) or the planispiral zig-zag type of coiling illustrated by Ireland (1956, text fig. 5, 6-14). The type of coiling differs from that of *Ammovertellina* in that in the final stage the tubular chamber does not uncoil. The mode of coiling, however, is irregular when compared with that of *Glomospira* or *Glomospirella*. It appears to represent a style of coiling intermediate between *Glomospira* and *Ammovertellina*. In many respects the species is close to *Glomospira articulosa* Plummer, which coils in a haphazard, but compact, fashion.

Genus GLOMOSPIRA Rzehak, 1885

**Glomospira adhaerens** Parr

pl. 4, figs. 1-4

1942. *Glomospira adhaerens* Parr, p. 103, pl. 1, fig. 2; 1958, Crespin, **70**, pl. 13, figs. 6, 7.

The South Australian specimens are attached to quartz grains, coiled in *Glomospira* fashion, the wall is thick, with agglutinated quartz grains in a siliceous matrix.

*Dimensions.* Hypotype Ff391 diameter 0·75, diameter of tube 0·15 mm. near the end.

*Type Locality.* "*Lingula* beds", south side of Minilya River, near Coolkilya Pool, Wandagee Station; Quinnanie Shale.

*Material.* Hypotypes GSSA Ff391, Ff392, Ff393; 64 specimens.

*Distribution.* Stuart Range No. 3 and Boorthanna Bores.

*Stratigraphic Range.* Lower Permian.

Genus GLOMOSPIRELLA Plummer, 1945

**Glomospirella nyei** Crespin

pl. 4, fig. 13

1958. *Glomospirella nyei* Crespin, **70**, pl. 13, figs. 1-5.

Only the specimens from Lake Phillipson Bore are small and within the range of the type series described by Crespin. There seems to be no criterion but size to distinguish the specimens from Stuart Range No. 3 Bore from *G. nyei*.

*Dimensions.* Hypotype diameter 1 mm., diameter of tube 0·15 mm.

*Type Locality.* Cundlego Crossing, Minilya River, Western Australia; Cundlego Formation.

*Material.* Hypotype GSSA Ff394; 100 specimens.

*Distribution.* Locality Ware 5 (5/641/5), Lake Phillipson and Stuart Range No. 3 Bores.

*Stratigraphic Range.* Lower Permian.

Subfamily TOLYPAMMININAE

Genus TOLYPAMMINA Rhumbler, 1895

**Tolypammina undulata** Parr

pl. 4, figs. 5, 9

1942. *Tolypammina undulata* Parr, **104**, pl. 2, fig. 2; 1958, Crespin, **72**, pl. 19, figs. 7, 8.

The South Australian specimens are all small, about 0·5 mm. diameter overall, commonly adherent to quartz grains or to tubes of *Hyperammina hebdenensis*, as noted by Crespin.

*Type Locality.* "*Lingula* beds", south side of Minilya River, near Coolkilya Pool, Wandagee Station, Western Australia; Quinnanie Shale.

*Material.* Hypotypes GSSA Ff380, Ff381; 134 specimens.

*Distribution.* Locality Balta 6 (5/640/6), Stansbury, Minlaton, Boorthanna, Stuart Range No. 3 and Nullarbor No. 8 Bores.

*Stratigraphic Range.* Lower Permian.

Genus AMMOVERTELLA Cushman, 1928

**Ammovertella howchini** Ludbrook sp. nov.

pl. 4, figs. 6-8

*Description.* Test attached, consisting of a small proloculus followed by a long narrow tubular second chamber which at first winds back and forth in zig zag fashion and later winds irregularly over the surface of attachment; wall agglutinated with fine angular quartz grains in a small amount of siliceous cement; aperture at the open end of the tubular second chamber.

*Dimensions.* Holotype Ff414 diameter 1 mm. x 0·8 mm.; hypotype Ff415 diameter 0·65 x 0·625; hypotype Ff416 diameter 0·9 x 0·8 mm. Size of the tests is variable. The initial portion is usually about 0·5 mm. in diameter, but the total area covered by a single specimen may be as much as 2 mm. or more; diameter of tube 0·075 mm.

*Type Locality.* Cape Jervis; Cape Jervis Beds.

*Material.* The holotype Ff414, paratypes Ff415, 416, and 52 other specimens.

*Distribution.* Stuart Range No. 3 and Stansbury Bores; a pebble 36 mm. in diameter from Stansbury Bore is extensively covered with many encrusting individuals.

Superfamily LITUOLACEA

Family HORMOSINIDAE

Subfamily HORMOSININAE

Genus REOPHAX Montford, 1808

**Reophax subasper** Parr

pl. 4, fig. 15

1942. *Reophax subasper* Parr, 108, pl. 1, fig. 12; 1958, Crespin, 64, pl. 11, figs. 10, 11.

South Australian specimens have calcareous cement.

*Dimensions.* Hypotype length 0·8, width 0·4 mm.

*Type Locality.* "Lingula beds", east of Coolkilya Paddock, Wandagee Station, Quinnanie Shale.

*Material.* A single paratype on UWAGD slide 20770; hypotype GSSA Ff388, and 4 other specimens.

*Distribution.* Stansbury and Stuart Range No. 3 Bores.

*Stratigraphic Range.* Lower Permian.

**Reophax** (?) **thomasi** (Crespin)

pl. 4, figs. 16, 19, 20

1958. *Lugtonia thomasi* Crespin, 65, pl. 7, figs. 6, 7.

*Description.* Test free, straight, flaring slightly, consisting of as many as six chambers in a rectilinear series; sutures distinct, straight, depressed; wall very thick, agglutinating, with close set fine quartz grains in a small amount of calcareous cement, leaving very reduced chamber cavities connected by necks; aperture circular, terminal, surrounded by a thickened lip.

*Dimensions.* Hypotype (incomplete) length 1·2, width 0·5 mm.

*Type Locality.* 1¼ miles southwest of Nalbia Dam, Wandagee Station, Western Australia; Bulgadoo Shale.

*Material.* Hypotypes Ff389, Ff440; 30 specimens.

*Distribution.* A.O.C. North Renmark No. 1, Stansbury, Minlaton, Coorie Appa, Stuart Range No. 3, Nullarbor No. 8 Bores.

*Observations.* Conkin (1961, p. 276) has discussed the anomalous position of this reophacid species in the genus *Lugtonia* Cummings, which was placed by its author in the *Earlandiidae*. Crespin (1958, p. 35) states that the Western Australian specimens of *R. thomasi* have siliceous cement; South Australian specimens have calcareous cement. In thin section no evidence can be seen of the domed chamber form of *Lugtonia*, although most of the tests are poorly preserved and distorted. The thin section figured (pl. 2, fig. 20) shows the unusually thick wall and reduced chamber cavity, while the nature of the initial part of the test is somewhat doubtful. For these reasons the genus *Reophax* is used with caution until sections can be made of a wider range of undistorted specimens.

**Reophax tricameratus** Parr

pl. 4, fig. 14

Five specimens, some complete, occur in Nullarbor No. 8 Bore, 1,280-1,290 feet. The species is large; the wall of South Australian specimens consists of coarse quartz grains in calcareous cement.

*Dimensions.* Hypotype length 2, diameter 1·4 mm.

*Type Locality.* "Lingula beds", south side of Minilya River, near Coolkilya Pool, Wandagee Station, Western Australia; Quinnanie Shale.

*Material.* Paratype on UWAGD Slide 20772, hypotype GSSA Ff390; five specimens.

*Distribution.* Nullarbor No. 8 Bore, 1,280-1,290 feet.

*Stratigraphic Range.* Lower Permian (Artinskian).

Family LITUOLIDAE

Subfamily HAPLOPHRAGMOIDINAE

Genus RECURVOIDES Earland, 1934

**Recurvoides wilsoni** Ludbrook sp. nov.

pl. 5, figs. 1-10, 15

*Description.* Test free, subovate to flatly globose, asymmetrical, streptospiral; first whorl is planispiral but later whorls in different planes; periphery more or less oval, lobulate, chambers numerous, about seven in the final whorl increasing very gradually in size as added, inflated unless flattened during fossilization, with pseudochitinous lining; sutures distinct, depressed, nearly straight; wall coarsely arenaceous with coarse angular quartz grains in a siliceous matrix; aperture interio-areal apparently a small low arch, with a lip.

*Dimensions.* Holotype Ff405, greatest diameter 0·60, thickness 0·4 mm.; paratype Ff407, greatest diameter 1·25, thickness 1·0 mm.; paratypes are in the range of greatest diameter 0·75-1·25 mm.

*Type Locality.* Cape Jervis, Cape Jervis Beds.

*Material.* The holotype Ff405, paratypes Ff406-Ff413, Ff441; 348 specimens.

*Distribution.* Cape Jervis, Balta 6 (5/640/6); Stansbury, Minlaton, Beach Petroleum Troubridge Shoal No. 1, Boorthanna, Stuart Range No. 3 Bores.

*Observations.* The genus *Recurvoides* has not previously been recorded from rocks older than Oligocene. The streptospiral test of *Recurvoides wilsoni* is very variable in shape and when fully developed is most closely related to the Recent *R. turbinatus* Brady, *R. contortus* Earland and *R. trochamminiforme* Höglund. The axis of coiling in *R. wilsoni* as in *R. trochamminiforme* continues to change throughout the development of the test. Immature specimens are planispiral and similarly coiled to the genus *Adercotryma.*

Both *R. contortus* and *R. trochamminiforme* inhabit cold waters or fjords. The relatively abundant numbers of *R. wilsoni* at Cape Jervis in beds deposited in an over-deepened valley or fjord appear to parallel the occurrence of *R. trochamminiforme* in Gullmar Fjord. *R. contortus* occurs off South Georgia and in Antarctic waters.

Species of both *Adercotryma glomeratum* (Brady) and *Recurvoides turbinatus* have been described from Arctic waters. Both species occur together at several stations off Greenland, at depths of between 31 and 91 metres and also off Humboldt Glacier at 201-2 metres (Loeblich and Tappan, 1953).

Sectioning of the test shows (pl. 5, fig. 15) the interior of the chambers to be conspicuously lined with pseudochitinous material. *R. obsoletum* (Goës) and *R. higginsi* Bronnimann from the Cruse and Lengua Formations of Trinidad have been described (Bronnimann, 1953, p. 98) as having the interior of the chambers coated with a brown or thin ?chitinous film.

*Specific Name.* The species is named for Mr. R. B. Wilson of Geosurveys of Australia Ltd. who collaborated with the writer in selecting and describing the type section of the Cape Jervis Beds.

Subfamily LITUOLINAE

Genus AMMOBACULITES Cushman, 1910

**Ammobaculites woolnoughi** Crespin and Parr

pl. 4, fig. 17

1941. *Ammobaculites woolnoughi* Crespin and Parr, **304**, pl. 12, figs. 2a, b, 3a, b; 1958. Crespin, **75**, pl. 14, figs. 10, 11 (synonymy).

The three specimens from South Australia are poorly preserved and identification is doubtful. One specimen was recovered from Minlaton Bore, 554-560 feet, and one from Stuart Range No. 3 Bore at depths of 1,205 feet 5 ins. - 1,225 feet 5 ins. and 1,265-1,285 feet.

Family TEXTULARIIDAE

Subfamily TEXTULARIINAE

Genus TEXTULARIA Defrance in de Blainville, 1824

**Textularia bookeri** Crespin

pl. 4, fig. 18

1941. *Textularia eximia* Crespin and Parr, **305**, pl. 13, figs. 7a-c, 8a-c; 1947. Crespin, pl. 2, figs. 23, 24 (*non* Eichwald).

1956. *Textularia "exima* Eichwald" of Crespin and Parr, Cummings, **214**.

1958. *Textularia bookeri* Crespin, **77**, pl. 15, figs. 1-7.

South Australian specimens are usually distorted during fossilization and the arrangement of the early chambers is difficult to determine.

*Dimensions.* Hypotype Ff383, length 1·1, width 0·8 mm.

*Type Locality.* Four chains west of Farley Railway Station, Hunter River District, New South Wales; Dalwood Group.

*Material.* 40 specimens.

*Distribution.* Locality Ware 5 (5/641/5), Stansbury, Boorthanna and Stuart Range No. 3 Bores.

*Stratigraphic Range.* Lower Permian.

Family ATAXOPHRAGMIIDAE

Subfamily GLOBOTEXTULARIINAE

Genus DIGITINA Crespin and Parr, 1941

**Digitina recurvata** Crespin and Parr

pl. 4, figs. 10-12

1941. *Digitina recurvata* Crespin and Parr, **306**, pl. 13, figs. 9a, b, 10a, b; 1958, Crespin, **79**, pl. 15, figs. 10, 11.

*Description.* Test free, moderately elongate, flaring, of moderate size, consisting of a minute trochospiral stage with about 4 chambers in the initial whorl, followed by a triserial portion with about 9 inflated globular chambers increasing fairly rapidly in size, then becoming irregularly biserial and finally uniserial. Sutures distinct, depressed; wall coarsely agglutinated with coarse angular quartz grains in a thin matrix; aperture interio-areal, a very small arched slit near the base of the apertural face. In the figured hypotype (Ff418) and two other specimens from Stuart Range No. 3 Bore, in which the uniserial stage has developed, the aperture is subterminal, as it appears to be in the holotype (Crespin and Parr, pl. 13, figs. 9a-b).

*Dimensions.* South Australian specimens are relatively short and broad, adult specimens from Stuart Range No. 3 Bore attaining a length of 1·0, width 0·7 mm; most Cape Jervis specimens come within the range length 0·4-0·625, width 0·325-0·45 mm.

*Type Locality.* Foot of Victoria Pass, Mitchell Highway; Capertee Group.

*Material.* 29 specimens.

*Distribution.* Cape Jervis, Stuart Range No. 3 Bore, 1,285-1,367 feet.

*Observations.* The genus *Digitina* has been retained here only because no specimens of *Mooreinella* Cushman and Waters, 1928, are available for comparison. Cummings (1956, p. 214) suggested the possibility of the synonymy of *Digitina* with *Mooreinella* which was rejected by Crespin (1958, p. 36) on the basis of apertural differences. Although the aperture is usually, as Crespin emphasizes, at the base of the final chamber, in fully adult specimens with a uniserial final chamber, the aperture is, like that of *Mooreinella*, subterminal. However, no description of *Mooreinella* mentions the triserial stage, through which *Digitina* passes so conspicuously that the immature specimens from Cape Jervis with poorly preserved initial portions appear to belong to *Eggerella* (pl. 4, figs. 11, 12).

Phylum MOLLUSCA

Class GASTROPODA

Genus PERUVISPIRA Chronic, 1949

The single minute incomplete specimen 1 mm. diameter (pl. 5, fig. 13) is not sufficiently well preserved for its specific identity to be established, but with its generic range of Lower to Middle Permian, it is an important element in the fauna. The specimen was recovered from 1,285-1,305 feet in Stuart Range No. 3 Bore.

Gastropod indet. A minute steinkern of a protoconch also occurred in Stuart Range No. 3 Bore at 1,327-1,349 feet.

## Phylum COELENTERATA
## Class SCYPHOZOA
### Genus ? CONULARIA Sowerby, 1821

The fragment figured (pl. 5, fig. 14) of a pyritized cast appears to be that of a *Conularia*, from Stuart Range No. 3 Bore, 1,327-1,349 feet.

## OTHER ORGANIC REMAINS

Two species of ostracodes (pl. 5, figs. 11, 12) were recovered from Stuart Range No. 3 Bore, 1,327-1,349 feet, together with vertebrate teeth and bones.

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## EXPLANATION OF PLATES

### PLATE 1

Fig. 1. Cape Jervis Beds (C.J.) overlying Kanmantoo greywacke (K) at south end of type section, view southerly.
Fig. 2. View upwards through units 2 and 3 of Cape Jervis Beds to sandstone ledge of unit 4, showing inter-bedded sandstone and clay of unit 2, and boulders in layers.
Fig. 3. Southerly view of same part of section as Fig. 2, showing dip in lower part of section and bedding of boulders.
Fig. 4. Striated boulder on tillitic clay at northern end of type section.

### PLATE 2

Fig. 1. Gully erosion in Cape Jervis Beds, north end of type section.
Fig. 2. Erratic in boulder clay overlying Selwyn's rock (lower left), Inman River.
Fig. 3. King's Point, Encounter Bay; boulders on shore at foot of point overlain by boulder till, with sandstone at top right.
Fig. 4. Burrowings in sandstone at top of section, King's Point. This part of the sequence is doubtfully of Permian age.

### PLATE 3

All Figures X 30

Fig. 1. *Hippocrepinella biaperta* Crespin. Ff379, Minlaton 500-530 feet.
Figs. 2-6. *Hyperammina hebdenensis* Crespin. 2, Ff374a, with siliceous cement; 3, Ff374b, with calcareous cement, both locality 5/641/5; 4, Ff373, with siliceous cement, Stansbury 845 feet; 5, Ff375, with calcareous cement, Nullarbor No. 8 1290-1300; 6, Ff376, with siliceous cement, North Renmark No. 1 3755-3760 feet.
Fig. 7. *Hyperammina acicula* (Parr). Ff370, Stuart Range No. 3, 1205.5-1225.5 feet.
Figs. 8, 9. *Hyperammina coleyi* Parr. Ff371a; b, Cape Jervis CJ8.
Fig. 10. *Hyperammina expansa* Plummer. Ff372, North Renmark No. 1, 3785-3790 feet.
Figs. 11-13. *Saccammina orca* Ludbrook. 11, holotype Ff384; 12, Ff386, paratype both from Stuart Range No. 3, 1305 feet 8 ins. -1327 feet; 13, paratype Ff385, Stuart Range No. 3, 1327-1349 feet.
Fig. 14. *Lagenammina ampulla* (Crespin). Ff387, Stuart Range No. 3, 1305 feet 8 ins. - 1327 feet.
Figs. 15-16. *Thuramminoides sphaeroidalis* Plummer. 15, Ff377, with siliceous cement, Stansbury 830 feet; 16, Ff378, with calcareous cement, Stuart Range No. 3, 1305 feet 8 ins. - 1327 feet.
Figs. 17-18. *Ammodiscus oonahensis* Crespin. 17, Ff402, North Renmark No. 1, 3900-3905 feet; 18, Ff403, Stuart Range No. 3, 1020-1040 feet.
Figs. 19-21. *Hemidiscus balmei* Ludbrook. 19, holotype, Ff399, Stuart Range No. 3, 1225 feet 3 ins. - 1246 feet; 20, paratype, Ff400, Nullarbor No. 8, 1320-1335 feet; 21, Ff401, Donna No. 1, 870-880 feet.
Figs. 22-26. *Ammovertellina glomospiroides* Ludbrook. 22, holotype, Ff396, Stuart Range No. 3, 1265-1285 feet, the aperture can be seen at the top of the Figure; 23, holotype, reverse side; 24, paratype, Ff397, Stansbury, 210-215 feet. 25, 26, two views of paratype Ff398, Stansbury, 775 feet.

### PLATE 4

All Figures X 30

Figs. 1-4. *Glomospira adhaerens* Parr. 1, 2, two views of Ff391, Stuart Range No. 3, 1225-1246 feet, the quartz grain to which the specimen is adhering occupies the central half of Fig. 2; 3, Ff392, Stuart Range No. 3, 1182-1205.5 feet; 4, Ff393, Stuart Range No. 3, 1367-1400 feet, wound around quartz grain.
Figs. 5, 9. *Tolypammina undulata* Parr. 5, Ff381, Minlaton, 500-530 feet, adhering to *Hyperammina hebdenensis*; 9, Ff380, Stansbury, 775 feet, adhering to quartz grain.
Figs. 6-8. *Ammovertella howchini* Ludbrook. 6, holotype, Ff414, Cape Jervis; 7, paratype, Ff415, Cape Jervis, showing aperture at the end of the tube on the right-hand side of the Figure; 8, paratype, Ff416, Stuart Range No. 3, 1020-1040 feet.

Figs. 10-12. *Digitina recurvata* Crespin and Parr. 10, Ff418, Stuart Range No. 3, 1305 feet 8 ins - 1327 feet; 11, 12, Ff417a, b, Cape Jervis.
Fig. 13. *Glomospirella uyei* Crespin. Ff394, Stuart Range No. 3, 1265-1285 feet.
Fig. 14. *Reophax tricameratus* Parr. Ff390, Nullarbor No. 8, 1280-1290 feet.
Fig. 15. *Reophax subasper* Parr. Ff388, Stuart Range No. 3, 1349-1367 feet.
Figs. 16, 19, 20. *Reophax thomasi* (Crespin). 16, 19, Ff389a, b, Stuart Range No. 3, 1040-1060 feet; 20, Ff440, thin section, North Renmark No. 1, 3785-3790 feet.
Fig. 17. *Ammobaculites woolnoughi* Crespin and Parr. Ff395, Stuart Range No. 3, 1265-1285 feet.
Fig. 18. *Textularia bookeri* Crespin. Ff383, Stuart Range No. 3, 1060-1120 feet.

## Plate 5

All Figures X 30

Figs. 1-10, 15. *Recurvoides wilsoni* Ludbrook. 1, holotype, Ff405, Cape Jervis; 2, paratype, Ff407, Stuart Range No. 3, 1182-1205.5 feet, spiral view; 4, Ff407, apertural view, showing large quartz grain on apertural face; 4, Ff409; 7, Ff412; 9, Ff410; 10, Ff411, showing change in plane of coiling; 5, Ff406, showing apertural lip; 6, Ff408; 8, Ff413, showing position of aperture; 15, Ff441, Stuart Range No. 3, 1205.5 - 1225.5 feet, thin section, showing pseudochitinous lining of early chambers.
Figs. 11, 12. Ostracodes, Stuart Range No. 3, 1327-1349 feet.
Fig. 13. *Peruvispira* sp., M3180, Stuart Range No. 3, 1285-1305 feet.
Fig. 14. ? *Conularia* sp. Cr.3, Stuart Range No. 3, 1327-1349 feet.


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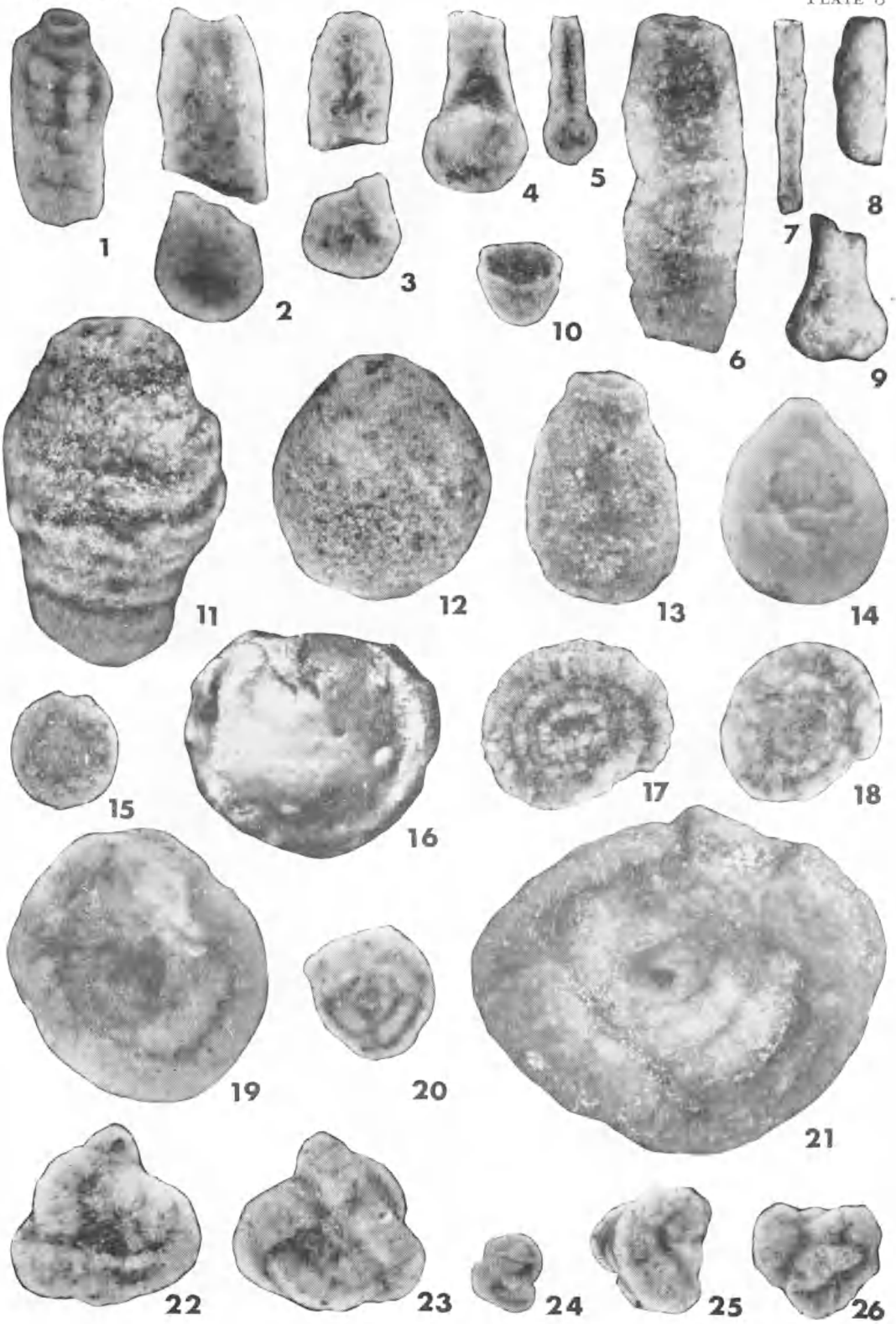
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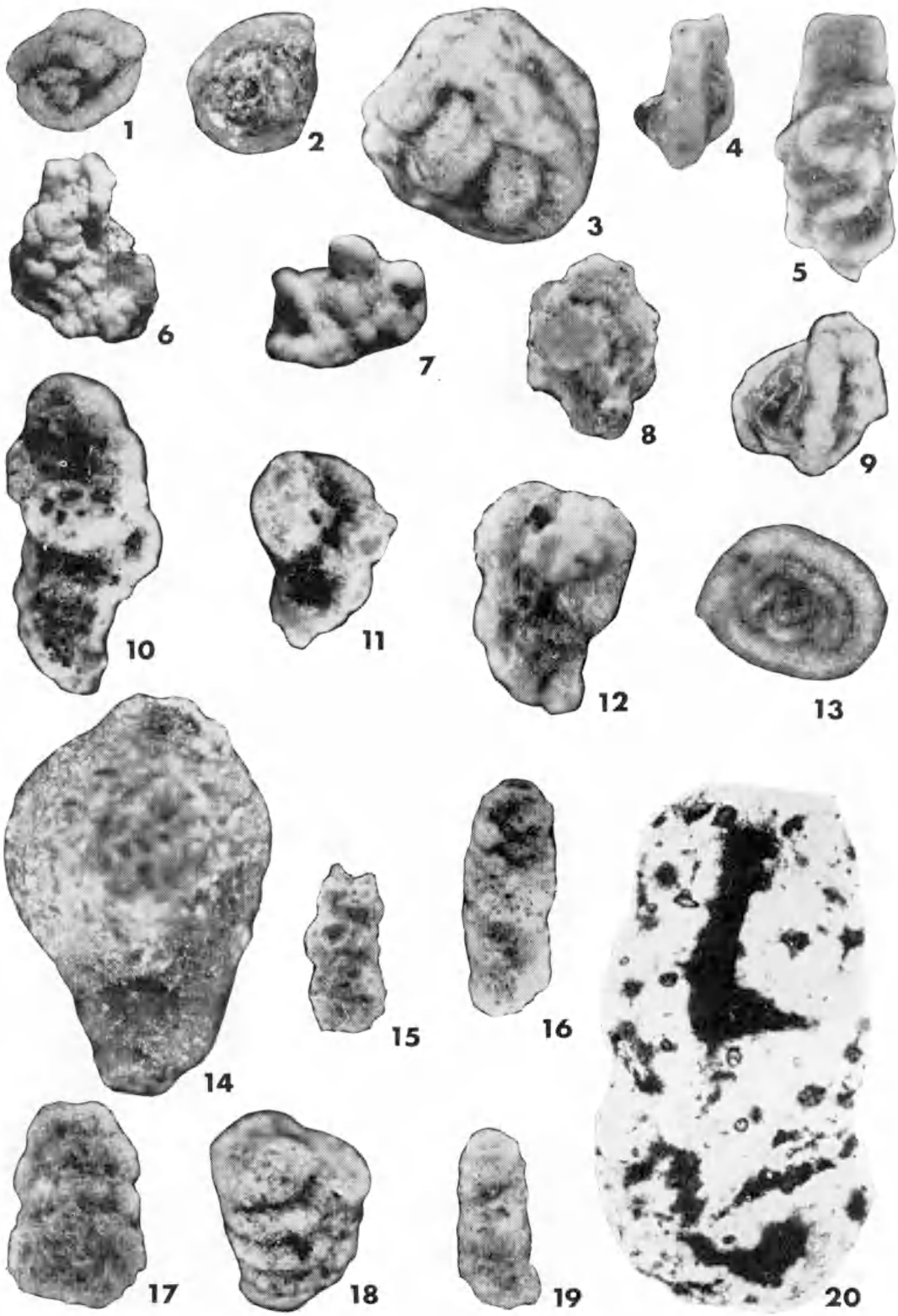
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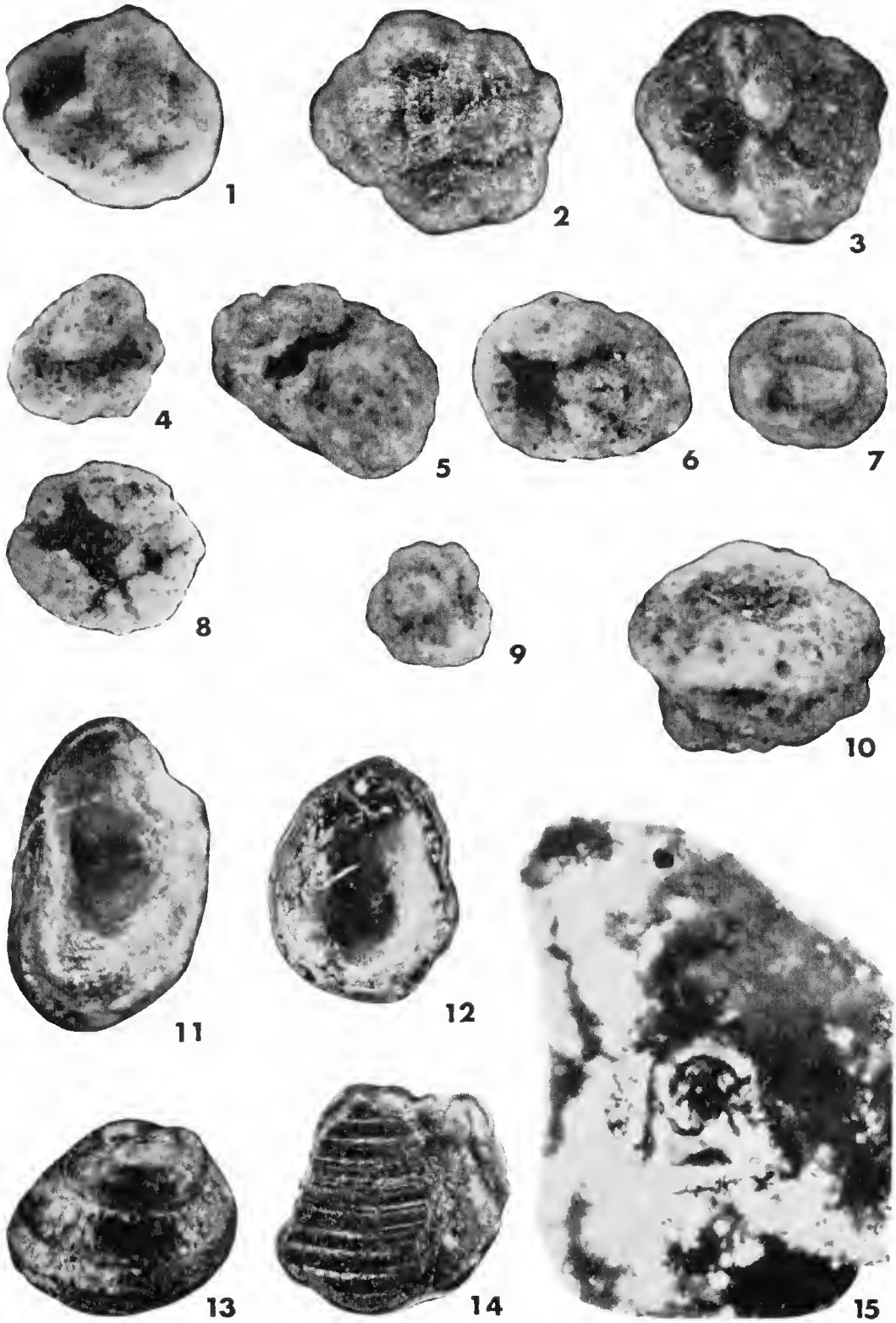
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